Berlese's Entomology.— Fascicles 21–22 (pp. 585–648) of Berlese's magnificent work [1] are just at hand. They conclude the discussion of the nervous system and begin that of the organs of special sense. Like the preceding fascicles these are not mere compilations but are rich in new facts for the student of insect morphology.

W. A. R.

BOTANY

The Fungi of Termite Nests.— We are accustomed to think of Belt's classic observations on the leaf cutting ants of South America as the beginning of our knowledge of the relationships between ants and fungi, but Petch [2] assures us that Sweathman in 1781, nearly a century before Belt's discoveries, stated that in tropical Africa some species of termites had chambers in their nests in which grew a kind of fungus used by the ants as food. Although the "fungus gardens" of the true ants of tropical America have been quite fully described, we have had until the present time no comprehensive treatment of the similar habits in the termites of the Eastern Hemisphere. Petch brings together and tests by his own extensive studies of the Ceylonese species, the scattered observations on this subject.

Ceylon does not afford such variety of form and size of termites as Australia and Africa, but the nests of *Termes redmanni* and *T. obscuriceps*, the only two species which Petch studied, are abundant everywhere except in the highest districts. The ant hills, roughly conical in form, are only about six feet high. Their upper portion is continued into one or more hollow conical structures called chimneys. The form of the nests varies greatly; they may slope gradually to the top of the chimneys, they may branch into several chimneys or they may have a solid apex and bear the chimneys at the side. They are built of earth and grains of sand brought up from the interior of the nest and cemented together by a secretion of the termites. A large portion of every nest is underground. In the early stages of development the presence of a nest is usually indicated by three or four chim-

[1] Berlese, A. Gli insetti, loro organizzazione, sviluppo, abitudini e rapporte coll, uomo. vol. 1. Milan. Societá Editrice Libraria.

[2] Petch, T. The Fungi of Certain Termite Nests. *Ann. Roy. Bot. Gard. Peradeniya*, 3: 185–270, pl. 5–21. 1906.

neys 10 –20 cm. high, surrounded by the scattered earth brought up in excavating the underground chambers. In fact in some cases the nest is entirely under ground and the chimneys are wanting. Reasons for the differences have not been found.

Internally the nest is composed of numerous chambers roughly oval in shape, 5–25 cm. in diameter and 5–15 cm. in height, connected by numerous galleries sometimes as much as 1 cm. in diameter but generally only large enough to permit of the passage of two or three insects at once. Similar galleries connect the chambers with the chimney. For a discussion of the purposes of this structure the original paper must be consulted. Some idea of the extent of the underground system of these nests may be gained from experiments which Petch made; in one case water was run in for two hours from a pipe delivering 15 gallons per minute but this was quite fruitless so far as filling the opening was concerned.

The chambers, except the royal cell, are generally nearly filled with a structure designated as the comb. This is a grayish or brownish mass, traversed in all directions by a labyrinth of anastomosing galleries, and closely resembling in general appearance a coarse bath sponge. The combs lie free in the chambers, leaving a clear space of 2 to 3 cm. between them and the roof and the sides. The comb substance is built up of closely packed balls of about 0.75 mm. in diameter, composed of finely divided vegetable substance. Under the microscope irregular pieces of ringed and pitted vessels, up to 250 microns in length, may be seen, as well as tracheids, sclerenchymatous cells, and the hyphae and spores of Halminthosporium, Diplodia, etc., all imbedded in a ground substance from which all structural detail has disappeared. The fact that the same substance is found in the intestines of the workers and soldiers, taken in connection with the regularity of formation of the comb from the small pellets, shows that this is made up of the excreta of the termites. It will thus be seen that the comb itself is not of fungus origin.

The surface of the comb is given a grayish or glaucous appearance by the presence of a thickly woven mat of fungus hyphæ. From this mass of hyphæ small stalked spheres arise by the combination of several threads into an upright stalk; these hyphæ branch repeatedly above and finally give rise to conidia. These are the "conidial formations" which have been described by all students of the fungi of termite nests. Injured spheres or stalks from which the conidia have fallen are never found on the comb, and it would seem that the termites in eating them must consume them at a single bite.

Some have suggested that this fungus is one which is found in the neighborhood of the nests on decaying wood and that it is introduced into the nest accidentally by the termites, but in an extensive investigation of the fungi of Ceylon in which large quantities of dead wood passed through his hands, Petch was never able to find any form at all similar to that in the nests.

Occasionally an agaric also develops from the comb. This species is the chief edible form of Ceylon and so generally is it esteemed that it is difficult to obtain perfect specimens, for the natives who collect them for food do not secure the long stipe intact and unfortunately they do not overlook many examples. This fungus has never been found growing from the hill itself but is always produced from the underground portions of the nest. The comb from which it develops may be as much as four feet underground but the most of Petch's specimens were found to grow from combs nearer the surface. The connection of the agaric with the hyphæ described above has not been demonstrated. Efforts to germinate the spores or to grow the sphere-producing mycelium from the tissue of the agaric have proven unsuccessful. It is not improbable, however, that they are stages of the same species. At first the agaric forms brownish-white, somewhat conical, tomentose columns 3 to 5 mm. in diameter and 1 to 2 cm. in height; in some cases Petch found as many as fifty of these on a single comb. All the developing agarics reach this stage but only one forms a Pluteus; the others cease growth before they reach the roof of the chamber and it has been found impossible to cause them to develop farther by experimental methods. This peculiarity of the species renders it almost impossible to obtain other than the mature and the very earliest stages. It has not been found possible to cause a normal comb to produce the agaric by artificial treatment, and after it has borne one, another will not be produced. No results have ever been obtained by digging in the nests at random in search of the intermediate stages; when the mature fruiting body has appeared on the surface no more may be expected from the same comb and it does not indicate that the other combs of the same nest are in a state in which they may be expected to produce agarics. The termites have been known to consume the stipe up to the surface of the ground and then to stop the opening. This agaric has been assigned to several genera, Lentinus, Collybia, Pluteus, Pholiota, and Flammula; Petch considers it a modified Volvaria. It has never been found when it could not be traced to the termite nests.

A second agaric seems sometimes to develop from the termite comb,

but probably only in wet weather. In this species a number of stipes may develop from the same comb.

If a piece of fresh comb be removed from the nest and placed under a bell jar the spheres will decay if the insects have been removed but both spheres and external hyphæ will be eaten if the termites remain. In the course of two or three days after the surface of the comb has been freed from these, small groups of erect hyphæ, indistinguishable from those which give rise to the agaric, but apparently derived from the interior of the comb-substance, appear and grow rapidly into tall thin structures resembling the conidial forms of Xylaria. Petch has carried on a large series of cultural experiments with this form and concludes that it is probably *X. nigripes*. The termites eat this too as it develops. After continued rain *X. nigripes* grows from deserted nests.

Besides these forms, Mucor, Thamnidium, Cephalosporium, and Peziza sometimes grow on combs removed from the nests. Since none of these are found in the nests, though some of them are capable of growing underground, it seems probable that the insects "weed out" undesirable fungi as they develop.

Although it is known that the termites will eat the fungi it is not definitely proved that they form the food of the insects. The two species studied prefer fungi, or wood which has been attacked by fungi. Whether a difference in food is a factor in the differentiation of the termites into workers, soldiers and sexed insects is not decided.

The author observes that the mycelium of *Entoloma microcarpum* is composed of spheres of swollen cells which in detail resemble the termite spheres but are not so highly developed. He thinks that the spheres of the termite nests and the "Kohlrabihäufchen" of the leaf-cutting ants investigated by Möller are parts of a normal mycelium and that their form has been little, if at all, modified by the insects.

J. Arthur Harris.

The Longleaf Pine.— Schwarz's *The Longleaf Pine* [1] is an attractive little volume, describing in a popular style the silvics of *Pinus palustris*, the valuable hard pine of the Southern States. The subject matter is considered under nine main headings which cover the character of the virgin forests of this tree and their natural rotation, the tolerance of the species, its relation to injuries by fire, insects, cattle, and swine, its rate of growth, and its technical forest management.

[1] Schwarz, G. Frederick. The Longleaf Pine in Virgin Forest, a Silvical Study. New York, John Wiley & Sons, 1907. 12mo, xii + 135 pp., illustr.